

# Patient and Hospital Characteristics Associated With Recommended Processes of Care for Elderly Patients Hospitalized With Pneumonia

## Results From the Medicare Quality Indicator System Pneumonia Module

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**Background:** Unexplained wide variability exists in the performance of key initial processes of care associated with improved survival of elderly patients (those  $\geq 65$  years) hospitalized with pneumonia. The objective of this study was to assess which patient and hospital characteristics are associated with performance of these key initial processes of care for hospitalized elderly patients with pneumonia.

**Methods:** A retrospective cohort analysis was performed using data from the Medicare Quality Indicator System Pneumonia Module for 14 069 patients 65 years or older hospitalized with pneumonia throughout the United States. Associations were calculated using multivariate logistic regression analysis between specific patient and hospital characteristics and 2 processes of care associated with improved 30-day survival: administration of antibiotics within 8 hours of hospital arrival and blood culture collection within 24 hours of arrival.

**Results:** Timely antibiotic administration was negatively associated with nonwhite race (African American: odds ratio [OR], 0.71; 95% confidence interval [CI], 0.60-0.85; and other racial minorities: OR, 0.79; 95% CI, 0.68-0.92), major hospital teaching status (OR, 0.79; 95% CI, 0.67-0.93), and larger hospital size ( $\geq 250$  beds vs  $< 100$  beds: OR, 0.68; 95% CI, 0.59-0.80). Timely blood culture collection was positively associated with larger

hospital size (OR, 1.61; 95% CI, 1.39-1.87). Performance of both processes of care were positively associated with registered nurse–bed ratios of 1.25 or higher (for antibiotic administration: OR, 1.23; 95% CI, 1.10-1.38; and for blood culture collection: OR, 1.43; 95% CI, 1.26-1.61) and fever (for antibiotic administration: OR, 1.35; 95% CI, 1.23-1.49; and for blood culture collection: OR, 3.07; 95% CI, 2.81-3.34) and were negatively associated with hospital location in the South (for antibiotic administration: OR, 0.77; 95% CI, 0.69-0.86; and for blood culture collection: OR, 0.85; 95% CI, 0.77-0.93).

**Conclusions:** Minority race, fever, nurse–bed ratio, hospital size and teaching status, and southern location are among the major patient and hospital characteristics associated, either negatively or positively, with the timeliness of performance of initial antibiotic administration and blood culture collection for patients hospitalized with pneumonia. Because performance of these processes of care is associated with improved likelihood of survival, medical providers should seek to eliminate the variations in care associated with these patient and hospital characteristics. In addition, the impact of nurse staffing changes on performance of key time-sensitive processes of care should be weighed carefully.

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**P**NEUMONIA IS the most frequent infectious cause of death and the sixth leading overall cause of death in the United States.<sup>1</sup> Because of the high mortality and corresponding high hospital admission rates and costs of care for patients with pneumonia,<sup>2</sup> pneumonia care is one of the targeted concerns of the Centers for Medicare and Medicaid Services' (CMS) Health Care Quality Improvement Program (HCQIP).<sup>3</sup> A major aim of HCQIP is to analyze patterns of medical practice and outcomes to identify opportunities for improvement in the quality of care.<sup>3</sup>

The strongest measure of quality of care is performance of processes of care that have confirmed links to important medical outcomes. To date, investigations conducted under HCQIP have identified 3 processes of care for pneumonia independently associated with reduced 30-day mortality. Administration of antibiotics within 8 hours of hospital arrival was associated with a 15% lower 30-day mortality.<sup>4</sup> Blood culture collection within 24 hours of arrival was associated with a 10% lower 30-day mortality.<sup>4</sup> Initial empirical treatment with a second- or third-generation cephalosporin along with a macrolide or with a quinolone alone was associated with im-

## PARTICIPANTS AND METHODS

### STUDY SAMPLE

As previously described,<sup>4</sup> the study sample was drawn from cases represented in the Medicare National Claims History File with a principal discharge diagnosis of pneumonia (*International Classification of Diseases, Ninth Revision, Clinical Modification* codes 480.0-480.9, 481.0, 482.0-482.9, 483.0-483.8, 485.0, 486.0, 487.0, and 507.0) or a principal discharge diagnosis of respiratory failure (code 518.81) and a secondary diagnosis of pneumonia. Using these diagnostic codes, approximately 500 cases were selected from discharges in each state, the District of Columbia, and Puerto Rico from October 1, 1994, through September 30, 1995. From these cases, copies of 25 561 medical records were collected. The diagnosis of pneumonia was confirmed if an initial working diagnosis of pneumonia was documented by a clinician and a chest radiograph taken within 48 hours of hospital presentation was interpreted as consistent with pneumonia. A total of 17 627 cases met these confirmation criteria. Confirmed cases were excluded if they had any of the following exclusion criteria: aged younger than 65 years, prior acute-care hospitalization within 10 days, infection with the human immunodeficiency virus or diagnosed as having the acquired immunodeficiency syndrome, history of organ transplantation, recent chemotherapy or immunosuppressive treatment, transfer from another acute-care facility, or death or discharge on the day of admission. If patients were hospitalized with pneumonia more than once during the study period (n=112), only the first hospitalization was included. Cases in which mortality outcomes could not be ascertained (n=33) were also excluded. Following application of these eligibility criteria, the final study population was 14 069 patients.

### DATA COLLECTION

The medical records of the identified patients were forwarded by hospitals to 1 of 2 Clinical Data Abstraction Centers. Data elements were abstracted from the medical record by trained staff using an electronic data collection instrument, and were merged with hospital claims data provided by CMS. As previously described,<sup>4</sup> the consistency of data abstraction was confirmed by a second independent abstraction of a subset of cases and calculation of  $\kappa^7$  statistics for confirmation and exclusion criteria ( $\kappa$ , 0.48-1.00), clinical characteristics ( $\kappa$ , 0.61-1.00), and processes of care ( $\kappa$ , 0.61-0.83).

### DATA ELEMENTS

Three categories of data elements were analyzed in this study: (1) patient characteristics, (2) hospital characteristics, and (3) 2 initial processes of care (antibiotic administration within 8 hours of arrival and blood culture collection within 24 hours of arrival at the hospital). Patient characteristics analyzed included demographic factors (age, race, sex, and residence in a skilled nursing or intermediate-care facility), treatment with an antibiotic within 48 hours before hospitalization, comorbid illnesses (cerebrovascular disease, congestive heart failure, coronary artery disease, neoplastic disease excluding skin cancer, liver disease, and renal disease), and physical examination findings at presentation (abnormal mental status, temperature, heart rate, respiratory rate, and systolic blood pressure). Initial laboratory values and test results (arterial pH; arterial partial pressure of oxygen; levels of blood urea nitrogen, sodium, and glucose; hematocrit; and pleural effusion) were collected for inclusion in the Pneumonia Severity Index (PSI) calculation.<sup>8</sup> The PSI was derived and validated as part of the Pneumonia Patient Outcomes Research Team cohort

proved survival compared with treatment with a third-generation cephalosporin alone.<sup>5</sup> Performance of all of these processes of care varied considerably from state to state.<sup>6</sup>

Recognition of the factors associated with the performance of these initial processes of care would aid the formulation of focused efforts to improve the quality of care for patients with pneumonia. This study was undertaken to identify patient and hospital factors associated with performance of antibiotic administration within 8 hours of arrival and blood culture collection within 24 hours of arrival of elderly patients hospitalized with this illness. These 2 processes of care were specifically chosen for analysis because they conform to reasonable clinical standards as designated by an expert national panel when the data set was collected,<sup>4</sup> are amenable to organizational quality improvement efforts, and are among the quality indicators HCQIP is championing in the Sixth Scope of Work.<sup>3</sup>

## RESULTS

### COHORT DESCRIPTION

The mean age of the study population was 79.4 years, and 23% were admitted from a skilled nursing or inter-

mediate-care facility. Of the study population, 58% had more than 1 comorbid illness and 61% had at least 1 laboratory abnormality or pleural effusion. Fifty-seven percent of the patients were admitted through an emergency department. Finally, 80% of the study population received antibiotics within 8 hours of admission and 66% had blood cultures collected within 24 hours of arrival.

### FACTORS ASSOCIATED WITH TIMELY ANTIBIOTIC ADMINISTRATION

Multivariable logistic regression revealed several patient characteristics that were independently associated with antibiotic administration within 8 hours of hospital arrival (**Table 1**). African Americans and other minorities were less likely to receive initial antibiotic therapy within the first 8 hours. Patients with cerebrovascular disease were also less likely to receive antibiotics within 8 hours of hospital arrival. Increasing heart rate, temperature, and respiratory rate were independently associated with timely antibiotic administration (Table 1). Patients who had received antibiotics within 48 hours before hospitalization were more likely to receive antibiotics in the hospital within 8 hours of arrival (Table 1). The percentages of patients receiving antibiotics within 8 hours

study to identify patients with pneumonia at low risk for mortality. Based on the clinical characteristics listed, patients are assigned to 1 of 5 risk classes for 30-day mortality. In this study, no patients were classified as risk class I because all patients were older than 50 years.

All of the patient characteristic variables were obtained from abstracted medical records, except liver disease and neoplastic disease, which were derived from a combination of abstracted medical record data and coded secondary diagnoses, and renal disease, which was assessed from secondary diagnostic codes alone. The times of performance of initial antibiotic administration and blood culture collection and the times of hospital arrival were recorded to the nearest minute. For analyses of the relationships between time of arrival and performance of the processes of care, times of arrival were grouped into intervals corresponding to the 3 traditional nursing shifts of 7 AM to 3 PM, 3 PM to 11 PM, and 11 PM to 7 AM. Information pertaining to whether patients were admitted through the emergency department or directly to a ward as either an urgent or an elective admission was collected from the Medicare Provider Analysis and Review file.

Hospital characteristics were collected primarily from the American Hospital Association 1994 annual survey.<sup>9</sup> The characteristics examined were geographic location, staffed bed numbers, average bed occupancy rates, number of emergency department visits per year, registered nurse–bed ratio, number of nurses, and teaching status. Teaching status was denoted as nonteaching if no medical school affiliation or residency program existed, limited teaching if a medical school affiliation or residency program was present, or major teaching if the institution was a member of the Council of Teaching Hospitals. Hospital locations were grouped according to the Bureau of Census regional areas (South, Northeast, West, and Midwest)<sup>10</sup> and classified as metropolitan and

nonmetropolitan according to their designation on the American Hospital Association survey.

## DATA ANALYSES

Bivariate associations were conducted between performance of antibiotic administration within 8 hours of arrival and blood culture collection within 24 hours of arrival at the hospital and each patient and hospital characteristic. Separate multivariate backward stepwise logistic regression models were then constructed for each of the 2 processes of care as the dependent outcome and using all of the patient and hospital characteristics that had bivariate associations with  $P \leq .10$  as independent variables. To adjust for the initial severity of illness, the demographic and clinical characteristics that determine the PSI were added to the multivariable model. Odds ratios (ORs) and 95% confidence intervals (CIs) relating to the performance of each process of care were determined for each patient and hospital characteristic. An OR greater than 1 indicates increased performance and a value less than 1 indicates decreased performance of the process of care relative to the reference category.

Partial residual plots revealed that model assumptions were appropriate.<sup>11</sup> The  $\chi^2$  goodness-of-fit statistic showed adequate fit for the models for blood culture collection within 24 hours of arrival ( $P = .28$ ) and good fit for the model for antibiotic administration within 8 hours of arrival ( $P = .66$ ). The areas under the receiver operating characteristic curve revealed good model discrimination (0.62 for the antibiotic model and 0.72 for the blood culture model).<sup>12</sup> Associations between PSI risk classes and performance of antibiotic delivery within 8 hours of arrival and blood culture collection within 24 hours of arrival were analyzed for trend using the Mantel-Haenszel  $\chi^2$  test. Calculations were performed using computer software (Stata, version 4.0; Stata Corp, College Station, Tex).

of hospital arrival were similar across PSI risk classes: 81% for those in risk class II, 79% for those in risk classes III and IV, and 78% for those in risk class V.

Admission to a major teaching hospital was also independently associated with less timely antibiotic administration. The administration of antibiotics within 8 hours of hospital arrival was positively associated with higher registered nurse–bed ratios. Patients were more likely to have antibiotics initiated within 8 hours of presentation in hospitals with 1 to 1.24 nurses per bed and with 1.25 nurses per bed or greater compared with patients in hospitals with less than 0.75 nurse per bed. In contrast, patients admitted to hospitals with more beds and higher occupancy rates had a decreased odds of receiving antibiotic therapy within 8 hours of hospital arrival (**Table 2**).

Hospital locations in the South, the Northeast, and metropolitan areas were independently associated with less timely administration of initial antibiotics. The percentage of patients receiving antibiotics within 8 hours of arrival varied with the time of presentation to the hospital (**Figure, A**). Analysis of 2-hour intervals within a 24-hour cycle revealed that performance of antibiotic administration within 8 hours of hospital arrival varied from 72% to 85%. Compared with the 3 PM to 11 PM shift, ar-

rival at the hospital during the 7 AM to 3 PM and the 11 PM to 7 AM shifts was associated with significantly reduced odds of receiving antibiotics within 8 hours of arrival (**Table 2**). Most patients with pneumonia arrived at the hospital during the daytime and especially around midday (**Figure, B**).

## FACTORS ASSOCIATED WITH TIMELY BLOOD CULTURE COLLECTION

Admission from a skilled nursing or intermediate-care facility was positively associated with blood culture collection within 24 hours of hospital arrival. The only comorbid illness with an independent association with increased blood culture collection was cerebrovascular disease (**Table 1**). The presence of abnormal mental status on presentation increased the odds of blood culture collection. Abnormal vital signs were also associated with an increased odds of blood culture collection, especially fever. Patients who received antibiotics before hospital arrival had a reduced odds of undergoing blood culture collection (**Table 1**). The percentages of patients undergoing blood culture collection within 24 hours of hospital arrival increased according to PSI risk classes: 61% for those in risk class II, 62% for those in risk class III,

**Table 1. Multivariate Analysis of Patient Characteristics and Performance of Initial Processes of Care\***

Patient Characteristics	Process of Care	
	Antibiotic Administration Within 8 h of Hospital Arrival	Blood Culture Collection Within 24 h of Hospital Arrival
Race		
White†	1.00	1.00
African American	0.71 (0.60-0.85)	NS
Other minorities	0.79 (0.68-0.92)	NS
Admission source		
Home†	1.00	1.00
Skilled nursing or intermediate-care facility	NS	1.23 (1.11-1.37)
Cerebrovascular disease	0.86 (0.78-0.96)	1.12 (1.01-1.24)
Physical examination findings		
Abnormal mental status	NS	1.38 (1.23-1.56)
Respiratory rate/min		
<20†	1.00	1.00
20-30	1.16 (1.01-1.34)	NS
>30	1.28 (1.09-1.51)	NS
Pulse rate/min		
<100†	1.00	1.00
100-124	1.16 (1.06-1.29)	1.18 (1.09-1.29)
≥125	1.35 (1.14-1.60)	1.30 (1.12-1.50)
Systolic blood pressure, mm Hg		
≥90†	1.00	1.00
<90	NS	1.47 (1.16-1.86)
Temperature, °C		
≥37.8†	1.00	1.00
>37.8	1.35 (1.23-1.49)	3.07 (2.81-3.34)
Prehospitalization antibiotic therapy	1.19 (1.08-1.32)	0.88 (0.80-0.96)

\*Data are given as odds ratio (95% confidence interval) for each process of care for patients with a particular characteristic compared with patients without that characteristic or with the reference characteristic. The odds ratios for performance of each process of care are adjusted using the other process of care, demographics, comorbidities, physical examination findings, receipt of prehospital antibiotic, time of arrival, hospital location, staffing, census region, and teaching status. NS indicates not significant.

†Reference value.

66% for those in risk class IV, and 72% for those in risk class V ( $P < .001$  for trend).

Patients treated in hospitals with a limited teaching status had a higher odds of blood culture collection than those treated in hospitals designated as nonteaching. A higher registered nurse–bed ratio and a larger hospital size were independently associated with blood culture collection within 24 hours of arrival (Table 2). Direct admission to the hospital floor, urgently and electively, was associated with a decreased odds of blood culture collection. A higher annual emergency department volume of visits was also independently associated with increased performance of blood culture collection (Table 2). Timely blood culture collection was less likely to occur in hospitals in the South and more likely to occur in hospitals in the Northeast.

#### COMMENT

This analysis reveals a striking number of associations between patient and hospital characteristics and performance of 2 important initial processes of care for elderly patients hospitalized with pneumonia. A common thread among many of these patient and hospital characteristics is that they may influence the provision of timely care by affecting the ability of health care providers to make prompt diagnostic and therapeutic decisions and to execute them. Recognition of the positive

and negative potential influences of these characteristics may help efforts to improve the delivery of key hospital services.

The ability to speedily reach a correct diagnosis and decide on treatment is strongly influenced by patients' presenting signs and symptoms. As found in this study, patients with certain abnormal vital signs consistent with a more severe infection had increased odds of receiving antibiotics in a timely fashion. Vital sign abnormalities, particularly fever, were also associated with successfully obtaining blood cultures within 24 hours of hospital arrival. In contrast, the diminished ability to communicate symptoms may account for the reduced odds of receiving timely initial antibiotic therapy among patients with cerebrovascular disease. Communication difficulties have been cited also as a possible explanation for the lower quality of health care provided to minority populations in the United States,<sup>13</sup> as observed in this study.

A history of treatment with antibiotics within 48 hours before hospital arrival was associated with an increased odds of timely antibiotic treatment. This finding is not surprising given that prior treatment implies that the diagnosis of a respiratory tract infection was already made and alleviates delays incurred by diagnostic decision making at the hospital. Furthermore, these pre-treated patients had lessened odds of undergoing blood culture collection, presumably because of the expected

**Table 2. Multivariate Analysis of Hospital Characteristics and Performance of Initial Processes of Care\***

Hospital Characteristics	Process of Care	
	Antibiotic Administration Within 8 h of Hospital Arrival	Blood Culture Collection Within 24 h of Hospital Arrival
Teaching status		
Nonteaching†	1.00	1.00
Limited teaching	NS	1.14 (1.03-1.27)
Major teaching	0.79 (0.67-0.93)	NS
No. of beds		
<100†	1.00	1.00
100-249	0.78 (0.68-0.88)	1.45 (1.29-1.63)
≥250	0.68 (0.59-0.80)	1.61 (1.39-1.87)
Nurse-bed ratio		
<0.75†	1.00	1.00
0.75-0.99	NS	1.26 (1.12-1.42)
1.00-1.24	1.17 (1.04-1.31)	1.28 (1.13-1.44)
≥1.25	1.23 (1.10-1.38)	1.43 (1.26-1.61)
Admission site		
Emergency department†	1.00	1.00
Urgent admission to ward	NS	0.73 (0.67-0.80)
Elective admission to ward	NS	0.69 (0.60-0.80)
No. of emergency department visits/y		
<10 000†	1.00	1.00
10 -19 999	NS	1.39 (1.23-1.58)
20 000-34 999	NS	1.53 (1.33-1.77)
≥35 000	NS	1.42 (1.20-1.67)
Average amount of beds filled daily, %		
<50†	1.00	1.00
50-59	NS	NS
60-74	0.87 (0.78-0.97)	NS
≥75	0.78 (0.70-0.89)	NS
Location		
Nonmetropolitan area†	1.00	1.00
Metropolitan area	0.82 (0.72-0.92)	NS
Census region		
West†	1.00	1.00
South	0.77 (0.69-0.86)	0.85 (0.77-0.93)
Northeast	0.73 (0.65-0.83)	1.35 (1.20-1.52)
Arrival time at the emergency department per nursing shift		
3 PM-11 PM†	1.00	1.00
11 PM-7 AM	0.80 (0.69-0.93)	NS
7 AM-3 PM	0.85 (0.77-0.94)	NS

\*Data are given as odds ratio (95% confidence interval) for each process of care for hospitals with a particular characteristic compared with hospitals without that characteristic or with the reference characteristic. The odds ratios for performance of each process of care are adjusted using the other process of care, demographics, comorbidities, physical examination findings, receipt of prehospital antibiotic, time of arrival, hospital location, staffing, census region, and teaching status. NS indicates not significant.

†Reference value.

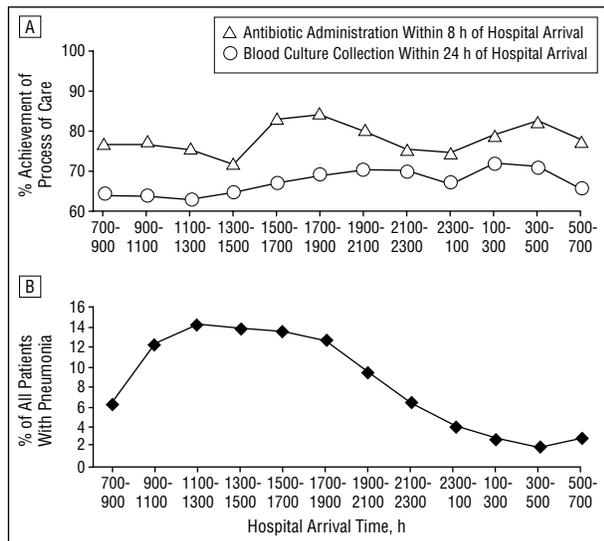
lower yield of blood cultures from patients already receiving antibiotics.

Previous studies<sup>14-16</sup> have shown that minority populations receive fewer medical services. This study reveals that, for community-acquired pneumonia, they receive less timely initial hospital care as well. The utility of race as a variable, however, must be qualified by acknowledgment of the subjective method by which it is defined in medical records.<sup>17</sup> Its association with other variables, such as socioeconomic status and cultural and societal factors, not evaluated in this study may also contribute to its links with specific outcomes.

Among the few characteristics examined that held significant positive associations for timely antibiotic administration and blood culturing was the number of registered nurses per bed. This finding buttresses concerns

about the impact of curtailed use of registered nurses on quality of patient care.<sup>18-20</sup> Higher nurse staffing may facilitate patient triage, assessment, and treatment. In-depth knowledge of each hospital's staffing arrangements, including use of nurse surrogates, is necessary to determine where in the care of patients with pneumonia the impact of higher nurse-bed ratios occurs.

Among the hospital characteristics examined, major teaching status as indicated by membership in the Council of Teaching Hospitals was associated with a lower likelihood of administering antibiotics in a timely fashion. Affiliation with a medical school or the presence of a residency without membership in the Council of Teaching Hospitals was associated with a better likelihood of collecting blood cultures. These findings may be partially attributable to a tendency, observed by 2 of us (J.M.F.



A, Relationships between the time of arrival at the hospital in 2-hour intervals and the percentage of patients arriving within each 2-hour interval in whom antibiotics were administered within 8 hours of arrival and in whom blood cultures were collected within 24 hours of arrival. B, Percentage of all patients with pneumonia arriving at the hospital within each 2-hour interval during the 24-hour period. All times are given in military form.

and T.P.M.), of some emergency medicine physicians to perform diagnostic tests but leave antibiotic selection to the admitting resident physicians and, thereby, incur a delay in the initiation of therapy. As previously noted, the differences in care between teaching and nonteaching hospitals may reflect differences in organization and delivery of care rather than exclusively the involvement of house staff.<sup>21</sup>

Admission to bigger and busier hospitals, as defined by number of beds and higher bed occupancy rates, was negatively associated with timely antibiotic delivery. For blood culture collection, almost the opposite was observed: increased hospital size favored performance, and bed occupancy rate held no significant association. This split between the odds of performance of diagnostic and therapeutic processes of care as related to hospital size and occupancy rate is attributable, no doubt, to numerous variables, such as drug retrieval factors and time to transport patients to the ward for the initiation of antibiotic therapy. In contrast to this observation of inconsistent quality of care associated with large hospital size is the finding by Keeler et al<sup>22</sup> that quality of care improves with increasing size among 5 disease states analyzed, including pneumonia.

Patients arriving during the 3 PM to 11 PM shift were significantly more likely to receive antibiotics in a timely fashion compared with those arriving during the other shifts. One explanation may be that performance of processes of care declines during times of peak clinical demand, as noted with prescribing accuracy.<sup>23</sup> Indeed, more patients admitted with pneumonia arrived during the 7 AM to 3 PM interval than either of the other 2 shifts. More factors must be involved, however, given that during the 11 PM to 7 AM interval when the least number of patients with pneumonia arrived, the odds of performance of antibiotic administration were also reduced. Pursuit of this link between clinical workload and performance

of processes of care will require exact data on staffing, complete patient load, and disease acuity that is beyond the scope of this study. Variation in performance of processes of care with time of presentation may be due to patient factors and not just hospital practices.

Variations in processes and outcomes of care according to hospital location are well recognized in the medical literature.<sup>24-26</sup> Metropolitan hospitals were less likely than nonmetropolitan hospitals to administer initial antibiotics in a timely fashion. This finding is consistent with the findings by Lave et al<sup>27</sup> pertaining to rural vs urban hospital variations regarding other pneumonia care practices. Although the size of the data set and its selection by state sampling preclude more detailed geographic analyses, the finding that performance of both processes of care lags in the South suggests some systematic effect that warrants further investigation.

The implications of our findings for those seeking to improve the quality of care for hospitalized patients with pneumonia are multiple. Clinicians should be aware that variations in the delivery of care may be attached to specific patient characteristics and should explicitly examine their own practices for evidence of such. Where suboptimal communication may be a factor, earlier attainment of chest x-ray films to evaluate for pneumonia may speed diagnostic decision making.

Inconsistencies in care associated with the presence of house staff may be amenable to corrective actions. In the case of timely initial antibiotic administration, for example, the first dose can be administered by physicians stationed in the emergency department, the entry point for most hospitalized patients with pneumonia, rather than wait for house staff to begin treatment. The storage of antibiotics in the emergency department avoids the delays in shipping from the pharmacy that larger hospitals especially may encounter.

For other aspects of staffing, such as registered nurse-bed ratios, hospitals should recognize and track the impact of staffing changes on the accomplishment of time-sensitive processes of care. Tracking patient flow with attention to time of day of presentation, patient volume, and the corresponding staff may also uncover explanations for lags in care. The decreased odds of performance of blood cultures among patients bypassing the emergency department and directly being admitted to the hospital wards may be ameliorated by the institution of standing orders or clinical pathways that call for blood culture collection in all patients with pneumonia.

Although this study was limited to the examination of the performance of only 2 processes of care, the 2 chosen pertain to much of what hospitals and clinicians provide early in the care of patients with pneumonia and, hence, seem fairly reflective of the quality of initial care. Remeasurement of the nationwide performance of these processes of care from 1997 to 1999 reveals similar performance of antibiotic administration within 8 hours of hospital arrival (median, 79%) and improved performance of blood culture collection within 24 hours of hospital arrival (median, 82%) compared with this data set. Changes in performance over time are to be expected given the increased attention devoted to quality of care in general and these quality indicators in particu-

lar.<sup>28</sup> Indeed, CMS is promoting as quality indicators antibiotic delivery within 8 hours of arrival and blood culture collection (modified to blood culture collection before antibiotic administration) in its HCQIP evaluation of pneumonia care among Medicare-insured patients. These 2 processes of care join choice of proper empirical antibiotic therapy and predischarge evaluation for pneumococcal and influenza vaccination as CMS's pneumonia care quality indicators. The Joint Commission on Accreditation of Healthcare Organizations,<sup>29</sup> moreover, is considering using these processes of care as core performance measures in its assessment of hospitals. Health care workers seeking to improve care for their patients with pneumonia and to meet CMS and Joint Commission on Accreditation of Healthcare Organizations expectations may be well served by using the findings of this study in their analysis of their hospital's performance of these processes of care.

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